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Marion Reissenweber

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By

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Institute for the Crippled and Disabled
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Psychological Monographs: General and Applied

The Use of Modified Block Designs in the Evaluation and Training of the Brain-Injured

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This report describes the development and present use at the Institute for the Crippled and Disabled, New York City, of modified Block Design materials and methods as an aid in evaluating and in training some disturbances in the visual perception of form, size, space, and organization incident to brain injury but not clearly outlined as clinically describable visual difficulties. The modifications in materials and methods are the outgrowth of the writer's personal need for such changes and her subsequent observation of similar needs in brain-injured patients receiving psychological retraining in visual perception and organization. The account is presented for whatever practical or suggestive help it may offer.

No attempt will be made in this report to discuss the theories of perception or the relative importance of the factors contributing to disturbances in visual perception and organization. With reference to such considerations, it may be empirically stated, however, that disturbances in visual perception and organization vary greatly in terms of the extent and nature of brain injury, as well as in terms of all the inherent and environmental factors which may influence an individual's response; that severe disturbances in the perception of form and space and in visual organization can be present in an individual who shows good ability in other aspects of thinking; and that when suitable methods of training are employed, some improvement in practical function may be expected in more instances than would seem possible on the basis of the Wechsler-Bellevue Performance Scale results in this series of patients.

[1] Grateful acknowledgment is made to Dr. Arthur L. Drew, Jr., Department of Neurology, University of Michigan Medical School, Ann Arbor, Michigan, for his counsel and encouragement in the preparation of this manuscript.

Statement of the Problem

The personal need for increased simplification and concreteness in the Block Design Cards of the Kohs (11) and Wechsler (16) series first became apparent when attempting to use these Design Cards as an aid in self-retraining after brain injury resulting in severe disturbances in visual perception and organization. Since at that time the writer was not familiar with the reports of Goldstein and Scheerer (6), it was of interest to discover later that the steps suggested by them for progressively simplifying the Design Cards in their own series (7) were among the writer's first felt needs. Very gradually it became possible to recognize some of the specific difficulties presented by the Kohs and Wechsler materials. Outstanding among these were the absence of block divisions on the Design Cards; the actual size difference between 1-inch blocks and Design Cards drawn to the scale of ½ inch to one block; the

completely different appearance of a two-dimensional Design Card and its three-dimensional block representation; the flat appearance of both Design Cards and block representations; and the presence of margins on the Design Cards.

From an evaluation of these observations there seemed reason to believe that, with modifications, block design construction could be more useful as a diagnostic aid in recognizing some disturbances in visual perception and organization. Furthermore, as a method for training or retraining in some cases of disturbances of form-space perception and visual organization, particularly within the field of central vision, there seemed to be indications of its value. To these ends modifications were made in the blocks, the design cards, the working environment, and the use of materials.

Clinical Material

During the last three years these materials have been used at the Institute for the Crippled and Disabled with brain-injured patients who have been referred either for qualitative psychological evaluation or for psychological retraining in visual perception and organization. Within the group of 50 patients with whom these materials have been used, there have been no selective criteria except a medical record of brain injury and evidence of resulting disturbances in visual perception and organization. The etiology of brain damage included birth injuries, war injuries, other accidental injuries to the head, encephalitis, brain surgery, and cerebral vascular accidents. The disturbances in visual perception and organization were primarily variously combined distortions and displacements of form, space, size, and position rather than clearly recognized visual agnosias, alexias, or aphasias. The patients ranged in age from 8 to 46 years. Verbal intelligence as estimated by the Wechsler-Bellevue Intelligence Scale ranged from 62 to 126. On the Wechsler-Bellevue Performance Scale, achievement ranged from 38 to 103, with all but eight patients at levels below 90. Discrepancies between verbal and performance scale achievements ranged from 6 to 73 points, with 50 per cent of the group averaging a difference of 30 points. A further publication will contain a discussion of the correlation of these findings with the results on our modified block design evaluation.

Recognition of Limitations in Standard Materials

In groping efforts to meet the personal feeling that the Block Design Cards of the Kohs and Wechsler series needed to be simpler and more concrete, the standard Design Cards of the Wechsler series were first redrawn from block models known to be correctly constructed. The actual block divisions that were thus exposed provided one tangible clue to visual orientation and organization. For example, in constructing Design Card 3 of this series (16), placing the two solid white blocks so that the lower right-hand corner of one block touched the upper left-hand corner of the other provided a spatial orientation for the remaining two blocks (Fig. 1a). The positions of these remaining blocks were then determined by noting that when correctly placed (as verified by a friend) the diagonal division on each of these blocks extended from the upper left-hand corner to the lower right-hand corner and that the red part of each block was turned to the inside. When so placed it was noted that the white tip of each block was to the outside. Since the writer found that this diagonal dividing line could be established by verbalizing its terminal

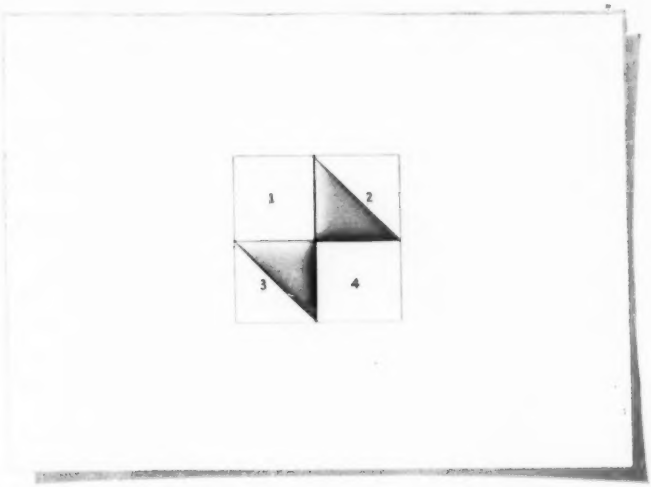

FIG. 1a. Use of Numbering and Indented Outline to Clarify Block Construction of Design Card 3 of Wechsler-Bellevue Performance Scale, Form I (Courtesy of Psychological Corporation, New York).

points and could be checked by kinesthetically tracing that direction, she considered this dividing line to be a much simpler and more reliable clue to block placement than were the white corners or the "bowknot" configuration of the design, which at that time could not be fused and had no wholeness. Since the block divisions and the diagonal lines seemed to provide the most personally useful clues to visual orientation and organization, the first drawings which the writer made of these standard designs were made with lines that indicated both the divisions between blocks and the lines that divided blocks diagonally. It should be noted here that this use of lines was a simple attempt to establish tangible orientation clues by which a Design Card could be broken down into manageable parts. This use of lines should not be confused with, nor considered comparable to, the use of lines as described by Goldstein and Scheerer (6). On these first drawings the block representations were numbered as another help in visualizing the breakdown of the whole design into parts (Fig. 1a). The outer lines of the design were then deepened by tracing them with the pointed end of a leather tooling instrument—a device which for the writer served first to establish a kinesthetic appreciation of the continuous outline of the figure against a background. Later this slightly indented outline was sufficient to raise the figure enough to provide a visual clue which increased the ease of both kinesthetic and visual tracing of the design, and which from some positions made it fleetingly possible to experience something akin to a foreground-background relationship.

From these drawings it was possible to draw the designs on an expanded scale that corresponded exactly to the size of the blocks. On these larger drawings both the whole and half-block divisions were indicated by lines. The outlines of the designs were then deepened with the leather tooler and, in addition, the figure itself was painted with a coat of col-

orless nail polish, which had little gloss, but which helped further to bring the figure up from its background (Fig. 1b). With these large cards it was possible to use the direct hand-kinesthetic method to trace some of the outlines and to help in determining the directional trend of stripes.

Even when the Design Cards were drawn to an expanded scale and tooled with line divisions to indicate their organization, construction continued to be

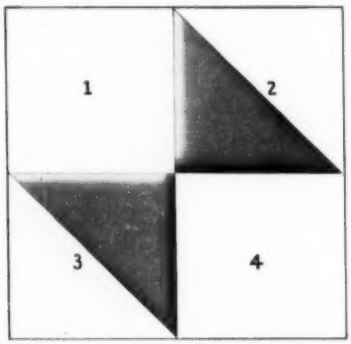

FIG. 1b. Further Simplification of Card 3 by Enlarging Drawing to Correspond Exactly with Size of Block Construction.

laborious and confusing because the completed three-dimensional block design bore little, if any, resemblance to the Design Card (Fig. 2). Correctness of construction could be established only by a slow and systematic tracing of each part on both the block design and the Design Card. There seemed to be no visual wholeness of configuration on either one. Furthermore, the appearance of extreme flatness of the Design Card was complicated by directional confusions that seemed to alter the length and proximity of lines as well as the size and position of solid parts (Fig. 2b). The same disconcerting flatness distorted clues to puzzles of the jigsaw type and destroyed completely the ability to appreciate cartoons. For example, the pieces of a jigsaw puzzle when seen from a sitting position lacked individual character and conveyed only a general color impression. From neither a sitting nor a standing position was it possible to appreciate the picture as a whole. It was noted consistently that the outline of individual pieces provided no useful clues for construction. Such puzzles could be successfully completed, however, when the individual pieces could be viewed from positions that made it possible to see and feel their depth and contour.

After some experimentation with various positions and lightings it was found that when the Design Card was placed on an inclined surface, it was possible to get some relief from the flatness that prevented any figure-background relationship. With further experimentation it was possible to devise an incline on which both the Design Card and the block representation of the design seemed to approach a three-dimensional experience (Fig. 3).

The improvement thus effected by the use of an inclined surface made it possible to localize another source of difficulty—namely, the inescapable influence of contours and surfaces of objects within the visual range. The edges of the table, the space between table and wall, the outline of window and door casings, the angulations of a book or box within the visual field all influenced judgments of shape and size unpredictably. Relative to this it should be noted that the contours of the visual world beyond the boundaries of immediate visual fixation can be monumental obstacles which are capable of increasing spasticity and disrupting visual organization to a degree which is difficult for a person without impairment in visual perception to understand.

FIG. 2. Comparison of Standard Two-Dimensional Drawing of Design 17 of Kohs Block Design Series (Courtesy of C. H. Stoelting Co., Chicago) (Fig. 2a) and Its Three-Dimensional Counterpart Drawn to Same Scale (Fig. 2b). In actual use, individually perceived differences are frequently greater because standard blocks are twice the size of this standardly scaled drawing.

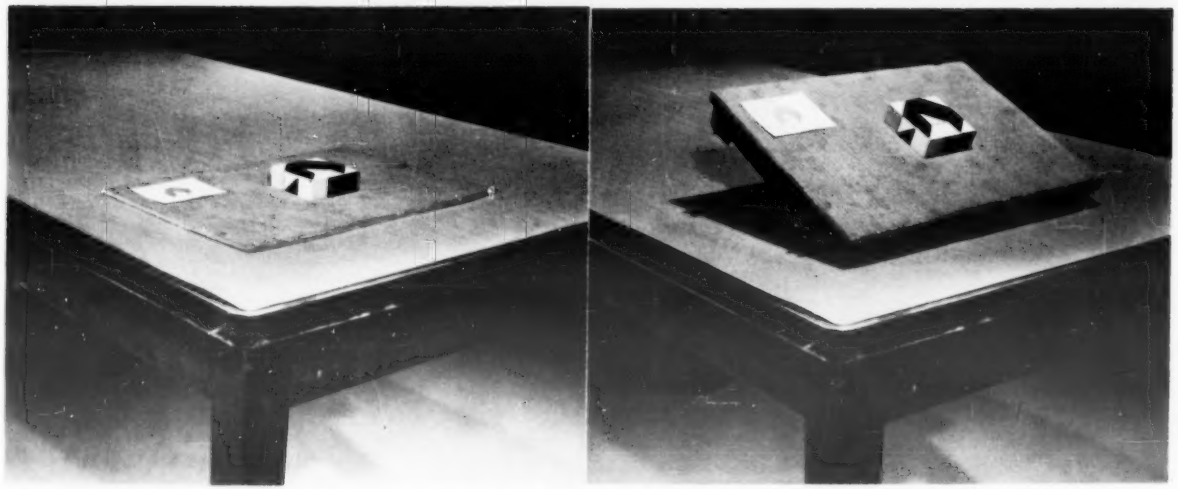

FIG. 3. Comparison of Card 11 of Kohs Block Design Series (Courtesy of C. H. Stoelting Co., Chicago) and Its Block Representation as They Appear on a Flat and an Inclined Surface.

When the physical environment was arranged in a way that ruled out gross disturbances of this sort, it was possible to see that at least one other obstacle remained. This was the white margins on the Design Cards.

With the help of these simplifications it became possible, through systematic practice and verbal analysis of the organization of each correctly completed design, to construct from memory each of the Kohs and Wechsler Design Cards from any one of four positions. Had the writer been familiar with the Goldstein-Scheerer Design Cards with lines (7), early attempts at retraining would undoubtedly have been easier. In the absence of this help, adaptations as previously described were made for each of the Kohs and Wechsler cards, and self-practice was directed toward the ability to construct the designs from memory. For example, in Card 7 of the Wechsler-Bellevue Scale, Form 1 (Fig. 4), the visual organization of this design would be fixed in memory by verbalizing as follows: The central unit is a white diamond made up of two two-block white triangles. The center part of each side is made up of a two-block red triangle placed with its point to the inside and touching the adjacent white point of the center diamond. Each corner is made with one block placed so that the red tip is to the outside. It was noted with concern, however, that although this device was personally a real help in reproducing the designs in the practice series, the ability to construct these designs did not increase skill in organizing and constructing a design not previously studied.[2]

[2] It should be noted that verbalization of this sort is not suggested as a uniformly helpful device. Subsequent experience has shown that with some patients it is a hindrance; with others it appears to be a help.

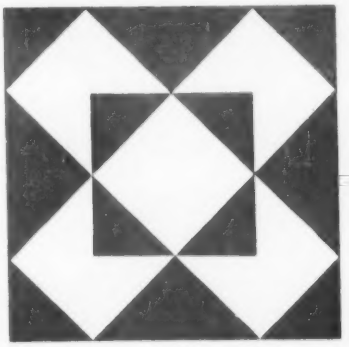

FIG. 4. Design Card 7 of Wechsler-Bellevue Performance Scale, Form 1 (Courtesy of Psychological Corporation, New York).

Subsequently, in observing the use of Kohs Design Cards by patients who had been receiving retraining in perceptual organization in this situation, there was further evidence to confirm the observation that persons with good intellectual potential and severe perceptual disturbances could master the accurate construction of the Design Cards as a series of concrete tasks without any measureable improvement in their ability to analyze or construct unfamiliar designs.

Modifications in Blocks and Design Cards

Modifications in the blocks consisted in substituting 16 one-inch wooden blocks finished in black and white enamel for the standard cubes of red, white, blue, and yellow. Two sides of each block are black, two are white, and two are diagonally divided and finished half in black and half in white. For convenience these are boxed in sets of 16. In actual use this number is frequently supplemented to make a working set of 25. Another set of blocks consists of 16 one-inch wooden cubes that have been sawed diagonally to make 32 half-blocks.

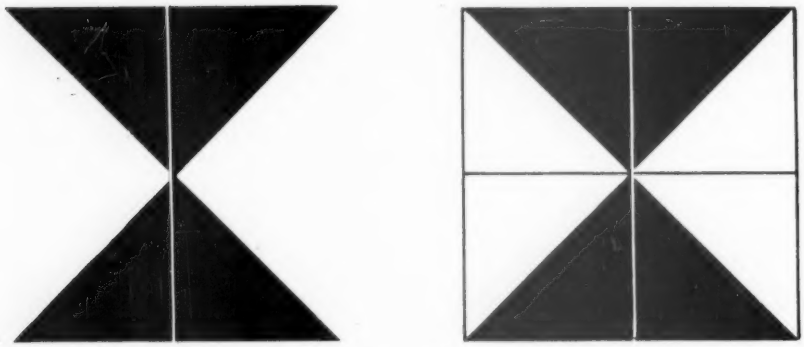

FIG. 5. Use of Black Half-Blocks to Build a Figure (Fig. 5a) Apart from Its Background (Fig. 5b).

Half of these are white, half are black. With these it is possible to build a figure apart from its block background (Fig. 5).

This change from the standard red-white, blue-yellow blocks used by Kohs (11), Wechsler (16), and Goldstein and Scheerer (7) to black and white was made in order to provide the sharpest and strongest contrast between figure and background, to eliminate the possibility of failure or confusion because of individual physical or emotional response to color (13), and to reduce the possibility of failure because of the presence of certain brain lesions that may make it difficult, if not impossible, for the eye to pick up small color differences (9, pp. 55-56; 10, pp. 25 and 125; 14, pp. 38-39). These considerations are important in this situation since routine medical procedures do not include a detailed differential diagnosis of brain-injured persons, nor do the routine psychological examinations rule out the possibility of color blindness or of color deviations related to other pathological conditions. Since such deviations alone do not bar a patient from acceptance for psychological retraining, efforts have been made to provide materials which present the strongest black-white contrast between figure and background and are, therefore, apt to be useful to the largest number of patients.

Since it was felt that the standard design cards were not entirely applicable to the problem at hand, original design cards in black and white were developed for use with these blocks. It should be emphasized here that these materials are not to be considered as a test. It is believed that they do serve a useful purpose as part of a qualitative evaluation of brain-injured persons, and that their evaluative usefulness continues when they are used in retraining. They are not, however, to be confused with, nor considered a substitute for, the Goldstein-Scheerer Cube Test (7). At present there are more than 50 different designs of varied size and difficulty planned to aid in recognizing and differentiating the nature of some of the disturbances in visual perception. These same designs have been applied to training and retraining in visual perception and organization. The sizes of the actual design cards vary from 1×1 inches to 5×5 inches. These variations depend upon the number of blocks required for the construction of a design, the scale used in drawing the design, and whether or

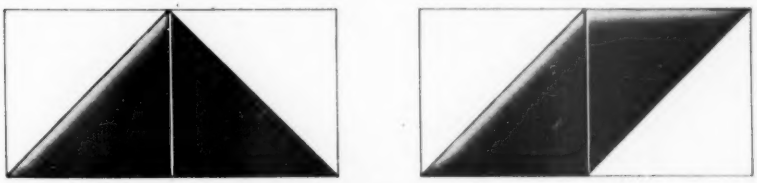

FIG. 6. Sample Design Cards for Basic 2-Block Units, Drawn to Full Scale, with Whole- and Half-Block Divisions Shown.

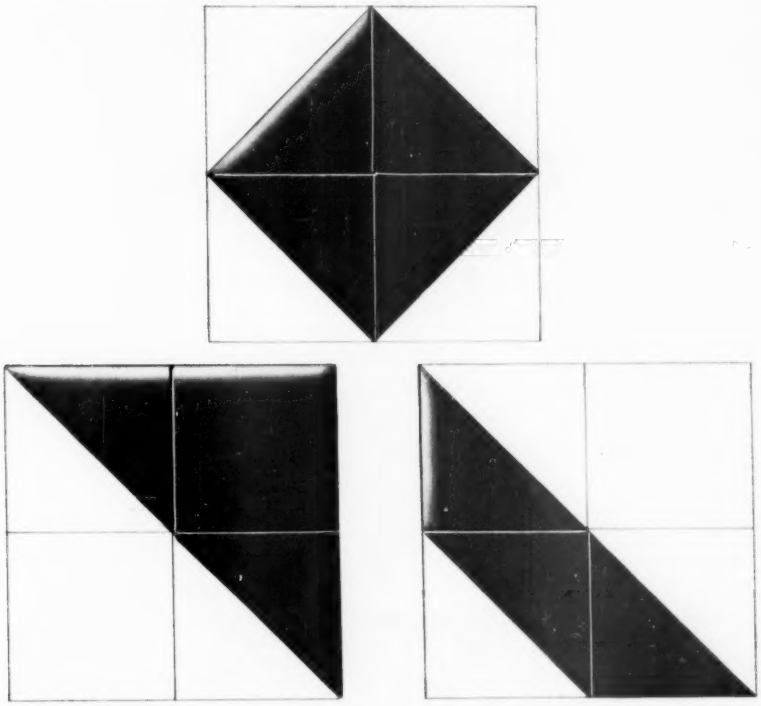

FIG. 7. Sample Design Cards for Basic 4-Block Units. These are drawn to full scale, with whole- and half-block divisions indicated.

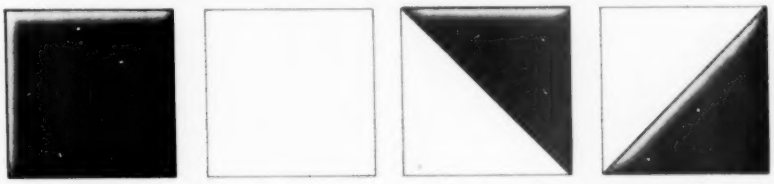

FIG. 8. Design Cards for Separate Sides of a Single Block. These are drawn to full scale so that construction can be clarified by placing half-blocks directly on top of corresponding parts of the card.

not extraneous margins are used. For example, a construction may require 25, 16, 9, 15, or 12 blocks. Several cards have been made up for 2 and 4 blocks (Fig. 6 and 7). There are also card replicas of single blocks so that when necessary it is possible to simplify a problem to a point where a single block and a single card are used (Fig. 8). In very severe cases, where it seems almost impossible for a patient to see any relationship between a three-dimensional block and its two-dimensional representation, the use of a three-dimensional cardboard model of a single block has often been found helpful. This is folded and cut in such a way

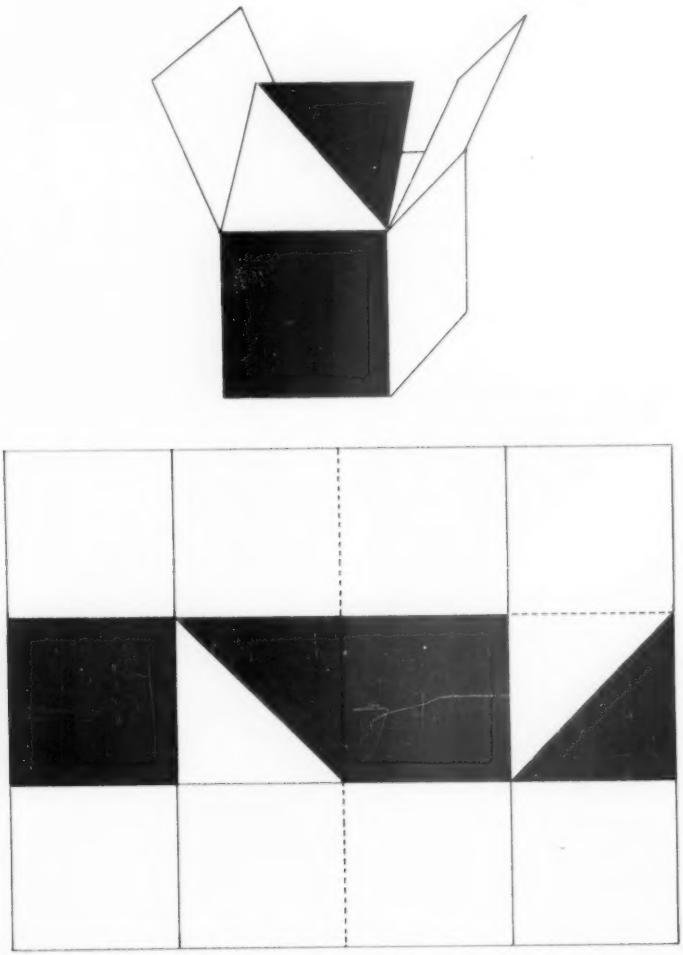

FIG. 9. Cardboard Model of Single Block which Can Be Used in Upright Position (Fig. 9a) and Can Also Be Flattened (Fig. 9b) and Masked to Show a Flat Representation of Each Side of the Block.

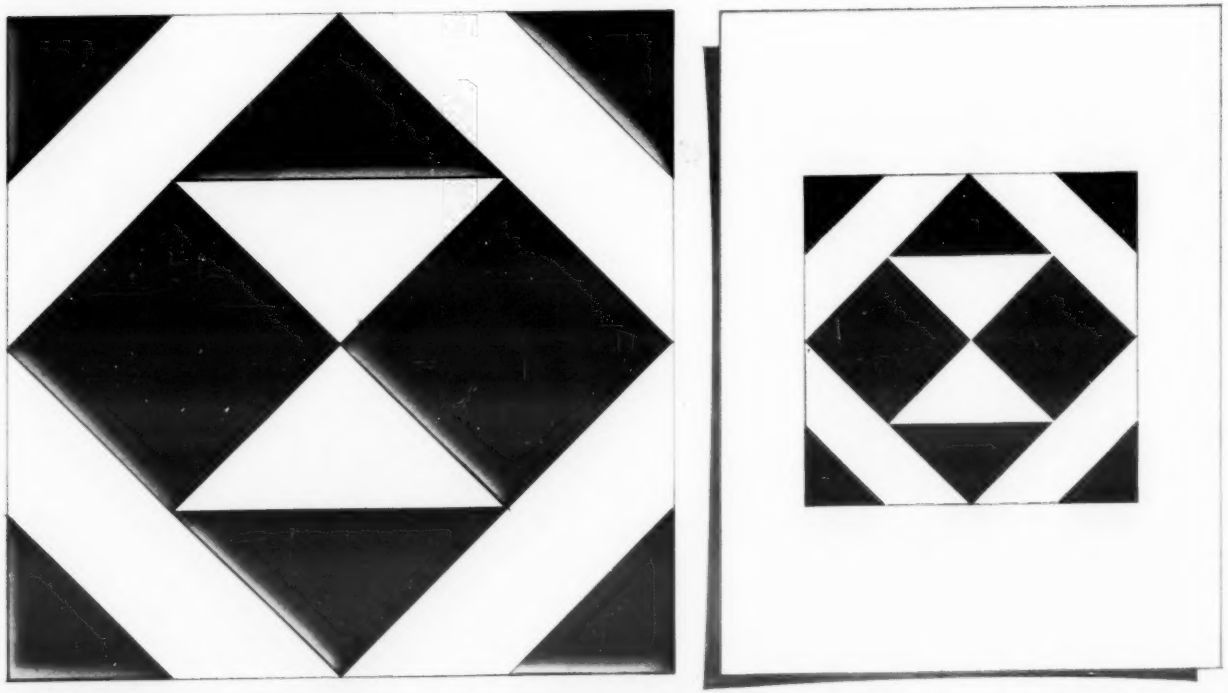

FIG. 10. Sample 16-Block Design Card, without Margins, Drawn to Actual Size of Total Configuration (Fig. 10a) as Compared with Same Design Drawn to Smaller Scale and Placed Within a Frame (Fig. 10b).

that it can stand as a one-inch cube and can also be spread out on a table. When using this in conjunction with a wooden block, each side of which can be shown comparably on the upright cardboard three-dimensional model and can also be flattened out and isolated by means of a cardboard mask which covers all but the side of the block under consideration, patients have frequently been able for the first time to visualize a relationship between a flat two-dimensional representation of a design and its three-dimensional counterpart (Fig. 9). The configuration of the total figure-backgrounds to be constructed is squares, diamonds, and rectangles. The design cards used during early stages of training are exactly the size and shape of the total figure-background to be constructed. That is, the design extends to the limits of the card without extraneous frame (Fig. 10a), thus eliminating the patient's need to find some way to cope with the very real visual obstacle that is frequently presented by the space between the frame of the design and the edge of the card (Fig. 10b). Furthermore, by making design cards in such a way that the figure and background to be constructed fill the entire card, it has been found possible to use orientation clues in terms of kinesthetic understanding—that is, top, bottom, lower right corner, etc. have concrete meaning, and block placement can actually be checked by feeling. In

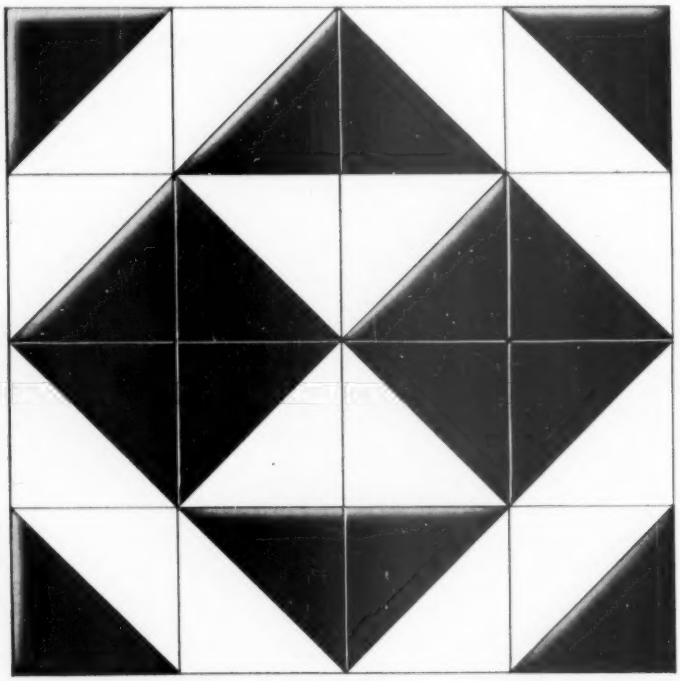

FIG. 11. Sample of 16-Block Design Card for Fig. 10 Drawn to Exact Size and Shape of Block Construction and Shown with Block Divisions.

patients who show directional confusions, the elimination of the margins which appear on the standard design cards seems to greatly facilitate training.

Some of the designs which have been found most useful at very basic levels are made up in several ways. The simplest of these are drawings similar to one of the modifications described by Goldstein and Scheerer (7, p. 54). They are drawn to the scale of one inch to a block. They are made up both with and without line divisions between the blocks and half-blocks (Fig. 11 and 10a). These same designs are also made up on a smaller scale in two forms, with and without line divisions. Neither form provides for any margin beyond the design itself. As previously noted, it has sometimes been found useful during early stages of training to reinforce the outline of the total configuration (Fig. 10a). Because of this the modified materials include some design cards that show an indented outline of the figure which is sufficiently clean-cut to permit patients whose hand coordination is adequate to trace the figure.

For later stages in training, designs consisting of a figure and background within a frame are placed on cards of various sizes and shapes. These do provide a margin between the frame of the design and the edge of the card. These are sometimes a square (Fig. 10b), a diamond, or a rectangle on a square or rectangular card, or they may be a square frame on a diamond-shaped card (Fig. 12). Further variations may be obtained by presenting the cards in rotated positions. The levels of difficulty of these designs are comparable in terms of physical form to the Kohs series, Cards 1-16, and all of the Wechsler cards, except for such simplifications as may result from the use of black and white instead of red, white, blue, and yellow.[3]

Some of the design cards that have appeared to be most useful have been drawn to various scales and placed on cards of various sizes. On these there are no frame lines to indicate where the unit to be constructed ends (Fig. 13). This level of difficulty is believed to be comparable to Card 17 in the Kohs series. The increased demands which this type of construction places upon the form and space orientation of a patient, as well as upon his visual organization and his ability to handle visual abstractions, would be apparent to the most casual observer. These added difficulties range from a gross loss of orientation and organization resulting from the fluid merging of design-background and extraneous margin to a recurrence of confusions in position and direction encountered by the patient at earlier stages in training. "You really did things to me with this one" is not an uncommon comment.

The design cards that have been developed for use with these modified blocks also include a series in which the design, without frame boundaries, is drawn upon a structured background. Some of these backgrounds are fairly regular and dependable in form and color intensity (Fig. 14a and b). Others are irregular but fairly even in intensity. Still others have scattered points of distraction (Fig. 14c). By rotating the positions in which these design cards are presented, it is often possible to gain additional clues to field abnormalities as well as to the nature of other existing disturb-

[3] "Simplifications" is used in the plural advisedly because I do not think that one can say that only a single simplification is effected for any individual patient.

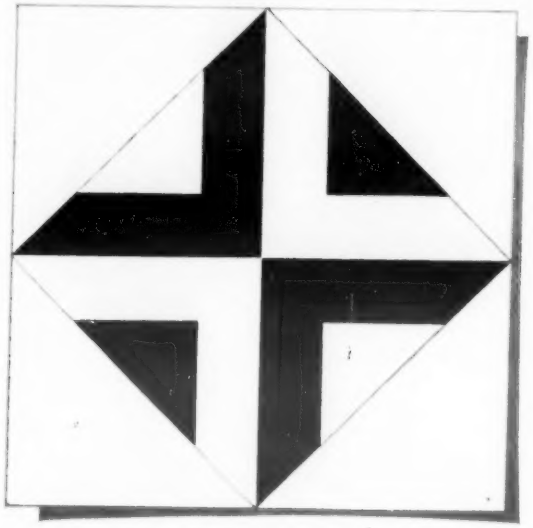

FIG. 12a. Sample Design Card for 16-Block Diamond Drawn to Small Scale and Placed within a Frame on a Square Card. The absence of block divisions and the space between the frame and the edges of the card make further demands upon visual perception and organization.

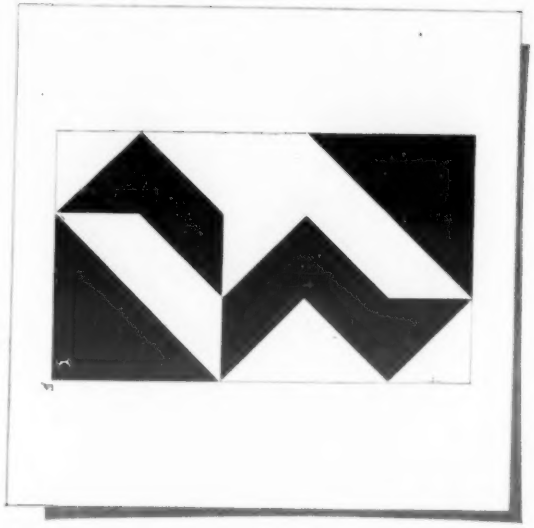

FIG. 12b. Sample Design Card for 15-Block Rectangle Placed within a Frame on a Rectangular Card. Changes are introduced here in the number of blocks required and in the use of margins of unequal width.

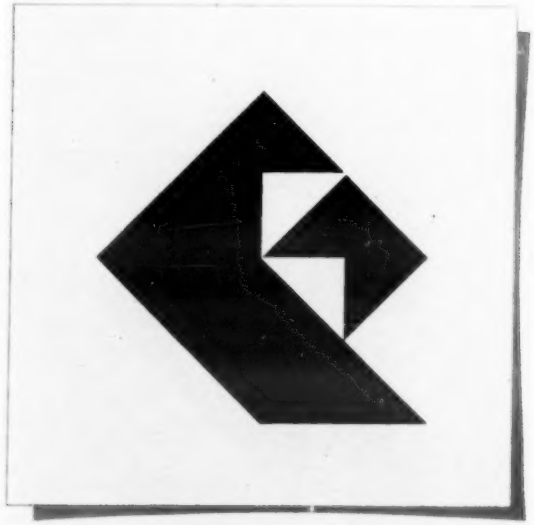

FIG. 13a. Sample Design Card for 16-Block Square on a Square Card. Difficulties are introduced here by the absence of block divisions and of a limiting frame, and by the use of margins which merge with the block background.

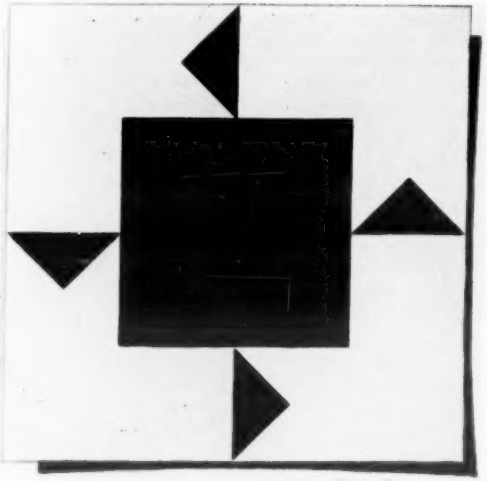

FIG. 13b. Sample Design Card for 16-Block Diamond Placed on a Square Card. Real difficulty is imposed here by the shape of the card, particularly since the design has no frame boundaries or block divisions.

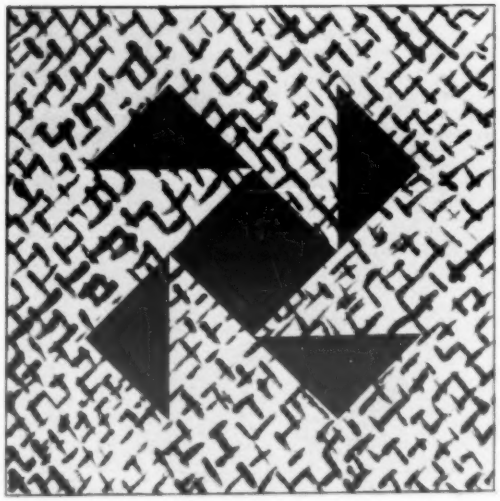

FIG. 14a. Sample Design Card for 16-Block Square on a Square Card with Structured Background. The absence of frame boundaries for the block construction and the use of margins and a closely structured background all impose additional demands on size perception and visual organization. In constructing this design there is a tendency to reproduce the central diamond by use of a single block.

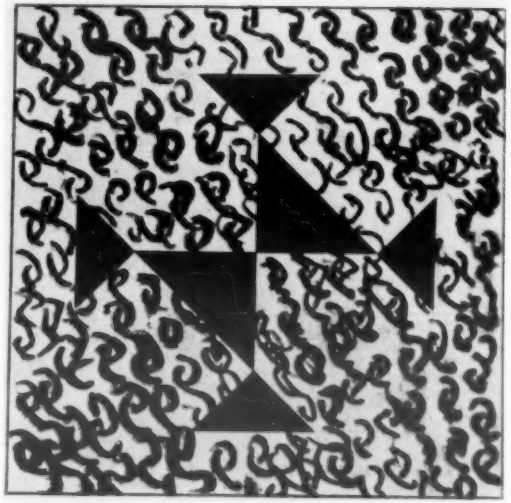

FIG. 14b. Sample Design Card for 16-Block Diamond Placed on a Square Card with Structured Background. The competing background, the absence of a limiting frame, and the use of a diamond on a square all impose demands which measure skill and further clarify difficulties.

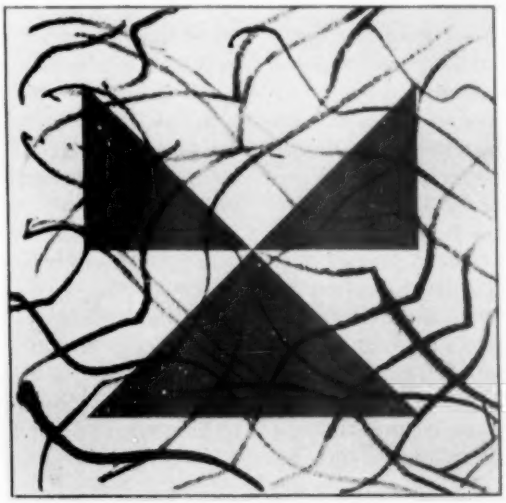

FIG. 14c. Sample Design Card for 16-Block Square Placed on a Square Card. This irregularly structured background introduces scattered points of distractibility and for some patients a factor of motion.

ances. This series of cards was first introduced to help in determining to what extent a patient was able to withstand the distraction of disturbing details within the background field. It was soon evident, however, that this kind of material was more broadly useful for both diagnostic and training purposes. For example, it was found that, in addition to the gross loss of visual orientation and organization resulting from figure-background competition, backgrounds of this sort frequently altered spatial orientation and perception (Fig. 14a and b). In some instances the fluid merging of design-background with extraneous margin seems to be a disrupting factor that destroys clues. In others, the configuration of the figure may be accurate, but distorted in size. The most common observable tendencies in such instances are the substitution of a single whole block for a four-block central square or diamond (Fig. 14a) and the substitution of a single block for a two-block triangle. In some cases it is noted that designs which had caused no difficulty when presented on unstructured backgrounds at earlier stages of training seemed to cause real distortions in size perception and spatial orientation when presented in a structured background. It was noted, furthermore, that to some patients some of these backgrounds caused more difficulty because they seemed to introduce an element of movement (Fig. 14c). Response to these designs, therefore, has not only been useful in uncovering previously unrecognized field abnormalities, but also in providing clues to locating practical visual-perceptual difficulties that are aggravated by motion or apparent motion. In this connection it is interesting to note that some of these patients have not only improved in visual perception and organization within the training situations which were planned with an awareness of the indi-

vidual difficulties involved, but have been able to progress from block construction to vocational and sheltered workshop training situations which presented the need to apply the basic training in visual organization to real movements and distractions within the central and peripheral fields of vision. It is encouraging also to note that some of these patients have moved forward from controlled training situations to complex life situations involving such adaptations to movement as the ability to walk alone on the sidewalk, to go shopping, and to use the subway independently.

Although all of these experimental designs are black and white, the color intensities vary somewhat in order to provide for such individual differences as that encountered in a young woman whose abnormal response to white was so sharp that the presence of white destroyed all visual organization. This was true whether the presenting situation was a design card with a white background, a friend wearing a white blouse, an expanse of white tablecloth, or a book with very white pages and broad margins. During the first several weeks of training with this patient it was necessary to shade backgrounds into a pale gray and to screen off from the designs any margins which were not an integral part of the block construction. For most patients, variations in color intensities and in dull and shiny finishes have been found useful as a further means of measuring actual gains in the ability to analyze and organize a problem of visual perception, as differentiated from a purely concrete improvement dependent upon maintaining uniformity in the appearance of the cards.

For a clear, sharp figure-background contrast the most satisfactory cards have been made on unruled white file cards. The figures have been filled in with a black indelible pencil moistened in water and used as a brush. This medium combines the advantages of a finer control than an amateur could achieve with a brush and a solidly fused figure which shows no stroke marks. A durable finish is then put on the cards by painting the entire surface with a coat of colorless nail polish or by spraying it with a plastic spray.

On the basis of growing experience it is becoming evident that some of the experimental designs appear to be of little use except as additional practice material. Others appear to be basic—that is, for patients without organic impairment in visual perception and organization these designs usually cause no difficulty, whereas in most patients who do have severe disturbances in these areas these designs serve as starting points for differential diagnosis. It seems possible that further experience with all modifications may result in several serial arrangements of designs selected in terms of their greatest usefulness. Each of these designs would be made up in all levels of difficulty, as previously described. It is not the writer's intention to suggest that these series should not be used interchangeably in terms of the individual needs of individual patients. To the contrary, it is felt that a flexible use of the design cards has value as a way of defining more clearly the nature of perceptual difficulties, as a measure of progress in retraining specific disturbances of visual perception, and as an index of a developing power in visual organization.

Modifications in the Working Environment

Another variable involved in these modifications is the environment in which training and retraining is carried

on. Under ideal conditions the room to be used should be large enough to permit each patient to be seated far enough from others to reduce extraneous visual stimuli resulting from the proximity of personal belongings or the movements of other patients. The walls and floors, as well as the surface of the working table, should be of dull finish and of uniform brightness. A warm gray, without gloss, has been found to be well suited to bringing out the maximum figure-background contrasts in block designs. The essential furnishings should also be of dull finish, and of a brightness corresponding to that of the walls, so that the general effect will be a merged background without the sharp breaks in contour which are frequently very disturbing to the brain-injured person with visual disturbances. Either natural or artificial light should be used alone. At no time should a combination of artificial and natural light be used. The artificial lighting should provide for individual shaded lights that can be adjusted to meet individual needs. In addition to collapsible and adjustable inclined surfaces built into the central working table, there should be at least one small table which can be adjusted in both height and angle for use by patients whose physical disabilities preclude the use of an adjustable stool.

Although the writer has not had such a working environment,[4] her experiences suggest that much can be accomplished with minor alterations and a few pieces of equipment which can usually be purchased at relatively small cost. The use of a table of conference size, rather than smaller tables, is advisable, particularly in small rooms. By covering its entire surface with a medium gray linoleum, a neutral background which accentuates the black-white contrast of the block designs is provided. This has the added advantage of reducing the glare reflected by varnished or painted surfaces. An adjustable long-arm lamp, or its equivalent, which can be adjusted to the needs of individual patients should be substituted for a ceiling light. Other special equipment should include at least two adjustable inclined surfaces. These may be lap tables with the legs and lower ledges removed, the sizes to be determined by what is available. Relative to this it has been noted that many of the patients who find an inclined surface helpful prefer the higher of the two models currently in use (Fig. 3). It is thought that this may be because, when elevated, this model seems to screen out more of the interference from the next larger visual field—namely, the surrounding table, its distant edge, and what lies beyond. These adjustable inclined surfaces are covered with thin mats of gray sponge rubber to keep the blocks from slipping and to reduce further the visual difficulty of reconciling the edges of the incline with the visual field between it and the edges of the work table. The angle at which these inclines are adjusted is determined by the patient's feeling of what seems best to him. When a flat surface is more comfortable, the patient usually indicates this and materials are presented accordingly.

The use of an adjustable stool or chair increases the possibility of adapting working distances and heights to the needs of each patient. This increase of distance above the working surface has often seemed to provide the first experience that a patient has had in achieving visual fusion or a "feeling of depth" in designs. The reality of this experi-

[4] At the present time such a room is under construction at the Institute for the Crippled and Disabled.

ence is evident in such spontaneous expressions as the comment made by a patient who, as she stood casually watching the completion of a block-design at an adjoining table, suddenly exclaimed, "Oh, if I could only reach far enough to build that design from here. Now it really makes sense!" Similarly it has not been unusual for a patient to ask, "Do you mind if I stand while I work? I can see it so much better. It has depth when I look at it from here."

Diagnostic Use of Modified Block Designs

In qualitative psychological evaluation no block work is attempted until there has been some exploration of the patient's ability to recognize similarities and differences in simple geometric forms. Solid block forms, line drawings, and pictures are used, and note is made of any clues which seem to be useful to the patient in selecting like forms. It is noted further whether he is able to differentiate only when the model is in all ways like the ones from which he is to make his choice, or whether he is equally well able to select the correct shape regardless of whether the model is a solid form or a line drawing, or whether it is larger, smaller, or a different color from the model presented to him. Note is also made of whether the patient is able to give these forms differential names, or is able only to indicate nonverbal recognition of likenesses and differences. It should be stated here that in order to understand the nature of the perceptual disturbance, it is fundamentally necessary to try to understand the patient's use of such terms as "straight," "up," "down," "long," "short," "big," and "little." In this connection the writer recalls the unnecessary complications introduced during the early weeks of training a patient with severe distortions of direction because of the failure to clarify with the patient the term "straight line." In this instance the patient's use of the term was strictly correct. By a "straight line" she meant any line which was not "wavy," while to the writer a "straight line" was one which was horizontal or vertical, as opposed to oblique or diagonal. This need for clarification is apparent both in birth-injured patients and in those whose brain injury was sustained at some later time.

If preliminary work with a patient does not suggest gross inability to recognize similar forms, the patient is first tried on a symmetrical black and white 16-block design which extends to the edges of the card on which it is drawn. No lines to mark the block divisions are shown on this first card. If, however, there is reason to believe that there may be real difficulty in this area, or if there are indications of strong feelings of insecurity, the first design to be presented will be one on which the block divisions are shown. When there is reason to believe that there may be serious disturbances in this area, the first design will be presented in actual block representation rather than as a flat card drawing. The patient's method of reproducing the design is carefully noted. Subsequent evaluative work with block design is determined by his initial performance and by spontaneous comments which he may make as he works. An effort is made to simplify the demands of the task to a point where either successful construction is possible or where a basic difficulty is revealed. Similarly, the demands are increased to the point where visual organization breaks down.

It should be said that in the qualitative psychological evaluation of brain-injured individuals, the modified black

and white blocks and original design cards are used to an extent determined by individual needs. This involves adaptability in simplifying tasks to meet needs for increased concreteness, as well as exploring an individual's ability to cope with problems which require increased function at levels approaching the abstract. It involves also an understanding of the facts that visual distortions of size, form, space, and direction, as well as such relationships as figure to background, and details to wholes, can interfere seriously with block-design performance of an individual who shows relatively little impairment in areas other than those involving visual perception.

A clear-cut illustration of this is the case of a young woman of 26. On the Wechsler-Bellevue Verbal Scale her intelligence was 109, with indications of much better potential. On the Wechsler-Bellevue Performance Scale her intelligence was 53. Qualitative psychological and ophthalmological evaluations revealed actual limitations in vision as well as severe disturbances in visual perception, visuomotor performance, and visual organization. In practical function these had interfered seriously with her vocational training in the simplest office practice routines. At practical levels, not dependent upon the use of visually perceived clues, there was no apparent impairment of abstract functions. In spite of the fact that she wrote slowly, she interpreted and wrote her interpretations of ten proverbs in just slightly more than 20 minutes. The abstract quality of her mental function in this area was high as may be judged from the following samples: "Don't wait to lock the barn until after the horse is gone," interpreted as, "Take precaution to avert disaster"; "You can't prevent the birds of sorrow from flying over your head, but you can keep them from building nests in your hair," interpreted as, "You can't prevent adversity, but you can prevent it from stifling you"; and "Fine words butter no parsnips," interpreted as, "Fine talk alone can't earn your living."

As previously noted, the nature of many perceptual distortions can be observed through the use of design cards. A discussion of the differential diagnostic possibilities of these observations is not within the scope of this report, but present experience suggests that such a discussion might be worth consideration at some later time.

On the basis of the qualitative psychological evaluation, any adjustments which seem to be indicated are made before systematic psychological retraining begins. When a question is one that requires further specialized medical evaluation, the patient is referred for an ophthalmological examination or for further neurological consideration in terms of specific questions that have arisen during the evaluation.

For example, one might cite the case of a young cerebral palsied woman of 19. On the Verbal Scale of the Wechsler-Bellevue her intelligence was 90, on the Performance Scale it was 43. Although it was the psychologist's impression that her verbal potential was "at least average and that her common sense was superior," she presented training problems in visual perception, eye-hand coordination, and visual organization. On the basis of the qualitative psychological evaluation it seemed unlikely that she could achieve binocular vision. The specific questions raised by this evaluation were presented to her ophthalmologist, and a prompt and cooperative report was received granting us full permission to concentrate upon the development of efficient monocular right-eyed vision, and to use other training techniques which seemed to offer promise. In this case the patient from the outset was spared a repetition of the failures that made her dread academic teaching. Within the first six months she had the satisfaction of being able to write legibly for the first time in her life.

Another illustration is the case of a young woman who, while serving in the army, suffered a left hemiplegia as the result of surgery to remove a brain tumor. She had been in the training class for office practice for some time before being referred for qualitative psychological evaluation. Recent progress had been slowed up by disturbing visual symptoms. Furthermore, although she appeared capable of using public transportation she persisted in saying that she could not do this unless someone was with her because she became very confused —particularly on her left side. It had been thought by her social worker that she might be unwilling to give up these symptoms for fear of losing some of her disability compensation. On the basis of an extended evaluation there seemed reason to believe that there was a real

field limitation on the left, for both distance and near vision, and that all visual function showed more confusion in the presence of moving objects. A major question seemed to be whether training emphasis should be directed toward treating a hysterical field limitation or toward developing greater skill in turning her body to view objects on the left. These and other questions were presented to the ophthalmologist. He reported that field studies revealed a left homonymous hemianopsia with macula sparing. His reply confirmed the fact that this patient would have difficulty viewing objects in the field of vision on the left side for both distance and near unless she moved her head to the left, and that training emphasis in occupational therapy and psychological retraining should concentrate on increasing her speed in turning her head to view objects on the left. It was reported further that her visual field difficulties were greater when viewing moving objects than when viewing static objects, and that this visual confusion would cause difficulties in transportation which could to a great extent be overcome by a process of retraining. Such training was instituted and the woman was relieved from further pressure to undertake independent travel at that time.

Quite differently oriented were the training goals and techniques in the case of a severely disabled cerebral palsied man of 22 who also appeared to have limitations in the peripheral fields. The visual confusion was increased when judgments had to be made in oblique directions. Although this patient traveled by himself, his gait when out of doors, or in a room where there was traffic with which he was not familiar, was conspicuously more unsteady and groping than when in more visually circumscribed situations. On the basis of the questions raised by our own evaluation, the ophthalmologist reported that this man's problem was not a field limitation resulting from brain damage, but rather was the result of very acute vision for distant objects. Because of this such a multiplicity of stimuli was admitted that he was unable to cope with them adequately, particularly since his condition was complicated by nystagmoid jerks and severe spasticity.

With very few exceptions this practice of delaying ophthalmological referrals until after our qualitative psychological evaluation has been productive in securing much more differential reports and recommendations from ophthalmologists than were received when a patient was referred for such an examination prior to qualitative evaluation. As a result it has been possible in some cases to reduce a patient's difficulties at the outset of training by such adaptations as concentration on the development of effective monocular vision, or by securing refractive assistance in "fogging" distortions, or in understanding symptoms as they relate to the whole problem of visual "extinction" and inattention as recently re-emphasized by Bender (3). These phenomena must be looked for since the failure to recognize them may result in serious misinterpretations of bizarre and striking deviations from normal responses, both in tests of visual perception and in practical daily living.

Training Adaptations of Modified Materials

The application of the previously described modifications of block designs to training and retraining depends entirely upon as complete an understanding of all the factors contributing to the patient's difficulties in form-space perception and visual organization as is possible in the present state of knowledge. *Individualized training in terms of individualized goals* is the basis of the entire technique, and upon it rests any favorable results that may be reported.

During the early weeks of training, work on a strictly individual basis has been found mandatory. During later stages it has been found that working with several patients at a time can be very valuable. The time when a transition from individual to group work should be made can only be determined on an individual basis. Similarly, decisions as to when an individual is ready to use Design Cards, and in what order these should be presented in either diagnostic or training situations depend upon the teacher's understanding of the individuals and upon the ingenuity and

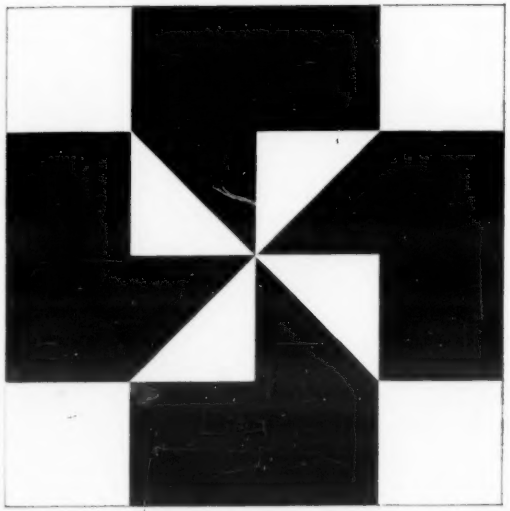

FIG. 15. Sample Design Card for 16-Block Square without Margins Which Combines the Use of 12 Solid-Color Blocks with 4 Diagonally Divided Ones.

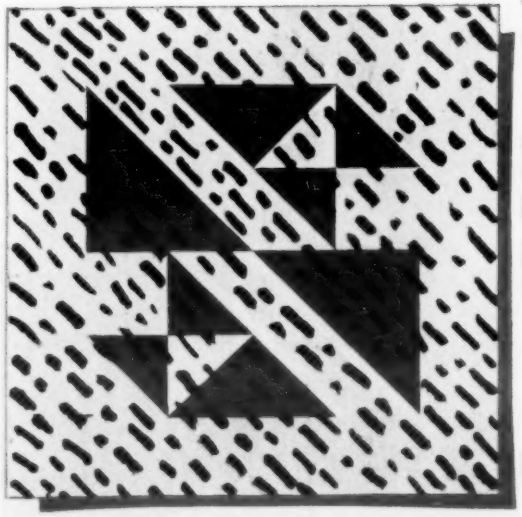

FIG. 16. Sample Design Card for 16-Block Square without Frame and with Margins Merging into Structured Background. Designs of this sort which combine several sizes of the same form have been useful at advanced levels of training.

skill which she can bring to the teaching situation. The fundamental guiding principle is that understanding must precede practice. To the brain-injured person, understanding comes through concrete experience at levels much below what an unimpaired person is apt to consider "rock-bottom" simplicity. Relative to this the writer has found that there seems to be little to lose and much to gain by beginning the training of all patients with various kinds of blocks and construction without the use of any design cards. For some patients this will mean a very brief experience with whole blocks in order to become familiar with their possibilities for constructing simple triangles and diamonds before they attempt to combine these in an organized way. From this exploratory experience the transition is made to building a block design from an actual block pattern. Only when a patient is readily able to note the likeness between his block construction and the block pattern is any attempt made to bridge the gap between a three-dimensional construction and its two-dimensional representation. For other patients the point of beginning will be solid block forms and training in getting a kinesthetic impression of the outlines of a circle, a square, a triangle, and a rectangle. For still others, the point of beginning may be a single block and enough half-blocks to build up a concrete understanding of each of the various sides of a whole block (Fig. 8 and 9). When necessary, the half-blocks can be placed directly on top of a whole block, thus matching each half-block with its mate. For patients with a minimum of manipulative difficulty, this use of half-blocks appears to be very helpful in providing some tangible clues to analyzing and organizing block designs at more advanced levels. For patients whose hand skills are too limited for this use of half-blocks, something of the same experience can be gained by watching the psychologist or another patient as he uses the half-blocks.

During the early stages with whole blocks and two-dimensional representations of them, the design cards are limited to those utilizing solid blocks or relatively simple geometric forms (Fig. 15). These triangles, diamonds, and three-quarter diamonds are used repeatedly, but in different positions, so that there is opportunity to develop real power in form perception and visual organization. Similarly, stripes are used in a variety of ways and directions. In later training, design cards are used that measure skill and provide training in size perception as well as in form. For example, designs planned for this purpose may be constructed of triangles of several sizes. Difficulty with size perception sometimes shows up very clearly when similar forms of different sizes are combined in a single design, particularly if the positions of the forms are varied (Fig. 16).

It should be noted here that the half-blocks were originally planned to make the visualization of a pattern apart from its immediate background more concrete. In actual use, these blocks have been helpful at various stages of improvement. In early training, before design cards are presented, the half-blocks are useful in providing concrete experience in the block construction of squares, triangles, diamonds, and diagonal stripes (Fig. 6 and 7). In this way each problem is more nearly reduced to uncluttered simplicity. At any level the half-blocks have been useful in providing a concrete understanding of size differences in forms of similar shape, as in triangles formed by one half-block, two half-blocks, four

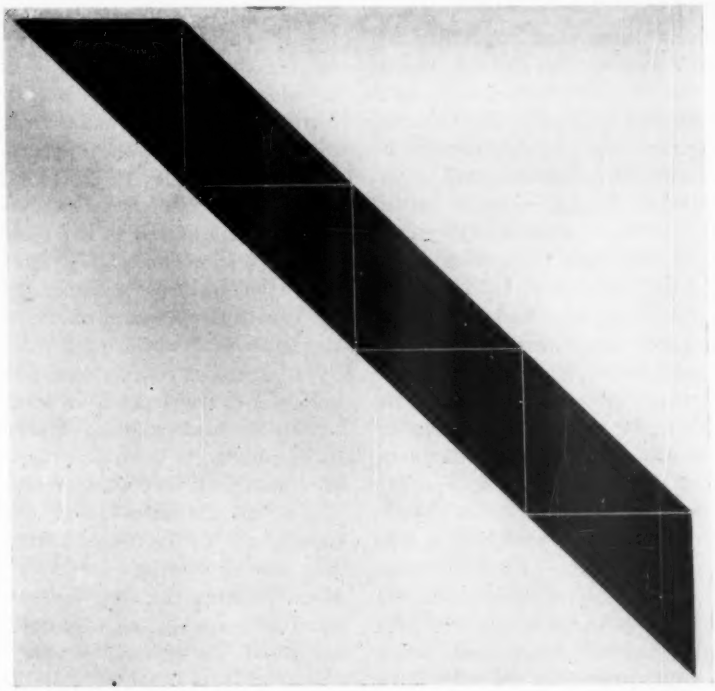

FIG. 17. The Use of 7 Black Half-Blocks to Construct a Diagonal Stripe Long Enough to Permit the Establishment of a Kinesthetic Impression of Its Direction.

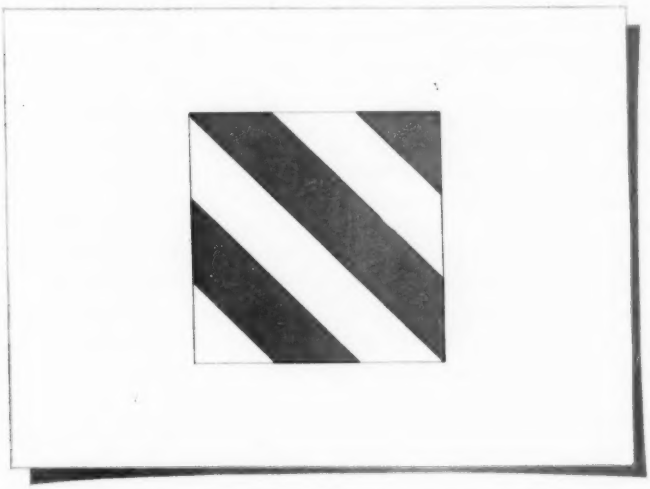

FIG. 18. Design Card 6 of Wechsler-Bellevue Performance Scale, Form I (Courtesy of Psychological Corporation, New York).

half-blocks, etc. More recently the half-blocks have been used to clarify the mechanical construction and direction of diagonal stripes. The feeling for a diagonal stripe, for example, appears to become more real when it is constructed by itself in a length sufficiently long to permit a patient to get a kinesthetic impression of it. This is possible when half-blocks are used and the block background does not have to be considered (Fig. 17). This appears to be especially important to brain-injured persons with spotty visual fields, who may be unable to appreciate a direction because too little of it can be seen in a design card such as Card 6 of the Wechsler-Bellevue Intelligence Scale, Form I (16) (Fig. 18). At all stages of training, the half-blocks have proved useful in providing a concrete experience as a basis for understanding the corners of squares and the tips of diamonds which are formed by a diagonally divided black and white block. In such instances the experience of being able to place a half-block in a position comparable to the card representation seems to help measurably in developing the ability to handle similar situations without the aid of blocks that are actually divided into tangible halves.

As analytical and organizational abilities develop, the abstract demands of tasks, as well as the physical complexity of the working environment, are increased proportionately. The patient no longer always works alone with the psychologist. He is brought into situations where he is obliged to cope with distractions from the corridor as well as with the movements and visual obstacles presented by having one or two other patients working at the same table or in close proximity. He is changed to various positions at the table so that practice is provided in adjusting his visual organization to the changes in his visual world. As skill and security increase, further demands are made upon a patient by increasing the difficulty of the construction itself. At times designs are constructed from memory. Sometimes they are reproduced in two-dimensional drawings, first from block models and later from memory. At other times they are constructed from memory, reversing the figure and background relationship by abstraction. Sometimes half-blocks are used to construct from memory design-figures independent of their block backgrounds. At some point in training the standard red-white, blue-yellow blocks and the Kohs Design Cards[5] are introduced. It has been interesting to note that at advanced levels of training, many patients do very well with this standard material, and to note the number of patients who without previous exposure to these materials since their initial experience with the Wechsler-Bellevue Scale are equally well able to construct the Kohs designs with the standard blocks, or to construct a Kohs design with black and white blocks, or to mentally convert one of the black and white experimental designs into a block construction in either the red-white or blue-yellow combination. In this connection it is perhaps noteworthy that the blue-yellow designs and the blue-yellow blocks seem to cause more difficulty with most patients than do the red and white. The relationship between this sort of block construction and the training possibilities in other aspects of abstract function

[5] The Kohs Design Cards, rather than the Wechsler-Bellevue or the Goldstein-Scheerer series, are used because this series is not used in the routine psychological evaluation in this situation.

would seem to be worth further exploration.

Summary and Conclusions

On the basis of experience with the modified materials there appears to be sufficient evidence to support the following tentative conclusions:

1. Severe disturbances in the visual perception of form and space can be present in a brain-injured person simultaneously with good ability in the abstract thinking required to interpret fables and proverbs.

2. Impairments in abstract ability as tested by block designs are frequently complicated by visual-perceptual difficulties resulting from abnormalities in the visual fields, involuntary movements of the eyes or head, torsions, physical rigidities, and other conditions that provide the individual with visually distorted clues.

3. Great caution should be exercised in interpreting a brain-injured person's performance on standardized psychological tests, especially those involving picture arrangement, object assembly, and block design, and on projective techniques such as the Rorschach and Draw-a-Person tests. Responses to these tests may be markedly influenced by perceptual disturbances such as field abnormalities and distortions of size, space, distance, and of those lines and markings which serve as useful clues to persons without perceptual impairment. Although the distortions of color and movement and the confusions resulting from visual "extinction" are too little understood at the present time to be thoroughly evaluated, their importance should not be overlooked.

4. Performance with block designs may sometimes be appreciably improved when such factors as the angle of display, the position of the materials or of the individual, and distractions in the working environment are understood and measures are taken to reduce the resulting difficulties.

5. There is need to emphasize that disturbances in the perceptual areas of vision may be responsible for the underlying insecurity of the brain-injured individual and may be a valid basis of his hesitation and inadequacy in seeking or holding a job (4).

6. Training or retraining of visual perception and organization demands time sufficiently long to break down poor habits of visual perception and to develop new ones. Variations in training are necessarily dependent upon the needs and capabilities of individual patients. In some cases this will mean training that is limited to teaching an individual concrete ways to meet the production standards of a single task in a sheltered workshop. In other cases training may be undertaken at broader and more basic levels. In still others it may be found that the patient has already worked out fairly adequate ways of meeting the demands of his daily living and that any disturbance of his visual patterns would be unwise.

7. The emotional tensions of the brain-injured person whose perceptual disturbances do not respond to retraining can frequently be greatly relieved when a sincere attempt is made to help him and his family understand that the perceptual difficulties which block his performance or cause him to be misunderstood are respectable aspects of his disability. Following such a relief of tensions there has often been noted an increase in the patient's response to other forms of rehabilitation.

8. In our experience, the modification of the block design method described in this paper is one of the most useful single methods of evaluating disturbances of visual perception and organization. Further studies in this area would appear to be indicated.

REFERENCES

1. Bender, M. B., & Teuber, H. L. Spatial organization of visual perception following injury to the brain. *Arch. Neurol. Psychiat., Chicago,* 1947, **58,** 721-39.
2. Bender, M. B., & Teuber, H. L. Spatial organization of visual perception following injury to the brain. *Arch. Neurol. Psychiat., Chicago,* 1948, **59,** 39-64.
3. Bender, M. B. *Disorders in perception.* Publication No. 120, American Lecture Series. Springfield, Ill.: Charles C Thomas, 1952.
4. Frank, R. L. The influence of unrecognized difficulties. *Psychoanal. Quart.,* 1948, **17,** 84-96.
5. Gibson, J. J. *The perception of the visual world.* New York: Houghton Mifflin, 1950.
6. Goldstein, K., & Scheerer, M. Abstract and concrete behavior: an experimental study with special tests. *Psychol. Monogr.,* 1941, **53,** No. 2 (Whole No. 239).
7. Goldstein, K., & Scheerer, M. *Goldstein-Scheerer Cube Test.* New York: Psychological Corporation, 1945.
8. Goldstein, K. *Aftereffects of brain injuries in war.* New York: Grune & Stratton, 1942.
9. Hebb, D. O. *The organization of behavior; a neuropsychological theory.* New York: Wiley, 1949. Pp. 1-106.
10. Kestenbaum, A. *Clinical methods of neuro-ophthalmologic examination.* New York: Grune & Stratton, 1947. Pp. 23-52.
11. Kohs, S. H. *Design cards.* Chicago: Stoelting, 1923.
12. Lehtinen, Laura E., & Strauss, A. *Psychopathology and education of the brain-injured child.* New York: Grune & Stratton, 1948.
13. Sarason, S. B., & Potter, E. H. Color in the Rorschach and Kohs Block Designs. *J. consult. Psychol.,* 1947, **11,** 202-206.
14. Traquair, H. M. *An introduction to clinical perimetry.* (5th Ed.) St. Louis: Mosby, 1948. Pp. 38-39.
15. Werner, H., & Thuma, B. D. A deficiency in the perception of apparent motion in children with brain injury. *Amer. J. Psychol.,* 1942, **55,** 58-67.
16. Wechsler, D. *Block Design Cards. Wechsler Bellevue Intelligence Scale, Form 1.* New York: Psychological Corporation, 1948.

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